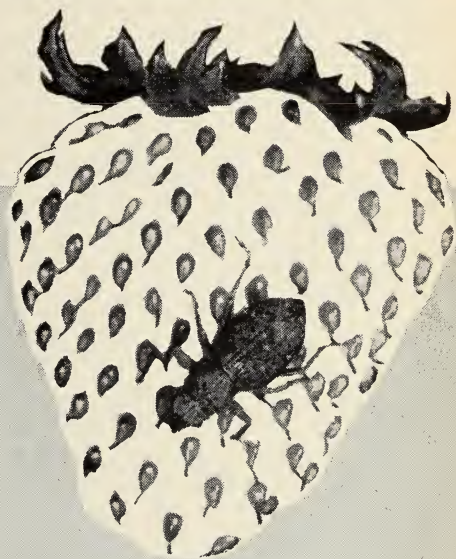




Division of Agricultural Sciences  
UNIVERSITY OF CALIFORNIA

# **STRAWBERRY PESTS**

## **IN CALIFORNIA**



**A guide for commercial growers**

**WILLIAM W. ALLEN**

***This circular . . .***

helps identify the many insects and mites which attack strawberries in California. It gives pertinent information about their life histories and habits as they affect control, and describes the pests and the damage they cause.

**Control measures are discussed in general terms** because specific recommendations change from year to year. **Consult your University of California Farm Advisor for the current year's recommendations.**

***Pest are discussed . . .***

in three groups: those feeding primarily on the leaves; those attacking flowers and fruit; and those living on the roots and crown. Where a pest does not limit itself to one of these parts, it is discussed under the heading where it causes the most serious damage. Where necessary, cross references are included.

<b>PESTS ATTACKING LEAVES . . . . .</b>	<b>5</b>
<b>PESTS ATTACKING FLOWERS AND FRUIT . . . . .</b>	<b>16</b>
<b>PESTS ATTACKING CROWN AND ROOTS . . . . .</b>	<b>28</b>

---

**The Author:**

William W. Allen is Lecturer in Entomology and Associate Entomologist in the Experiment Station, Berkeley.

# ***STRAWBERRY PESTS***

## ***in California***

### **A guide for Commercial Growers**

William W. Allen

Strawberry production in California has undergone considerable changes in recent years.

#### **Acreage**

Before World War II acreage averaged about 5,000 acres. During the war it declined to about 1,000. Since 1946, when the University of California introduced the Lassen and Shasta varieties, acreage increased continuously, and reached a peak of about 20,000 acres in 1957.

Yield per acre, too, increased markedly with the introduction of the new varieties. Average yields ranged from 500 to 800 trays per acre during the 1930-1940 decade, but rose to 1,300-1,700 trays for the period 1950-1955.

The increase in California strawberry production has resulted in an increasingly larger use of the berries for processing by freezing.

#### **Effect on pest**

All three of these changes have had pronounced effects on strawberry insect problems.

The acreage increase has tended to concentrate strawberry fields in certain areas which facilitated the rapid movement of the pests from field to field, and brought about increases of pest populations. Also, strawberries were planted in new areas where several new pests were encountered.

Production increase per acre has made pest control more important because the potential loss on each acre is higher if pests remain uncontrolled.

The shift of use toward processing for freezing has had the effect that certain insects which are inclined to remain in the berries have become more important because they result in contamination of the frozen product.

#### **Difficulties of pest control**

Pest control problems on strawberries are especially difficult because of the type of culture and the growth characteristics of the crop. Plantings usually remain in the field for several years, thus certain pests tend to become increasingly abundant each succeeding year. This is particularly true of pests living on the strawberry roots. Such insects are difficult to control while the plants are in the ground.

Many strawberry pests appear during the six-month harvest period during which the berries are picked every three to seven days. This long period of constant picking seriously restricts the kinds and amounts of insecticides that can be used without leaving toxic residues on the fruit.

There are numerous strawberry pests in California. This circular discusses those that are found in nearly every field; others encountered only in certain areas; and still others which are insig-



nificant for years but flare up and become abundant periodically. Not included in this publication are pests which are only rarely seen and are of no economic significance.

### **New insecticides and their application**

Insecticides available today are superior to those used 15 years ago; yet you still must obtain thorough plant coverage to achieve adequate control. The systemic insecticides which are carried to the various plant parts by the sap of the plant sometimes achieve better control but still must be applied thoroughly; for they are mostly carried in an outward direction.

Different insect species live on different portions of the plant; insecticides will succeed only if they contact those portions where the pest lives. For instance, two-spotted mites, living on the lower surface of the leaves, are almost wholly unaffected by insecticides deposited on the upper surfaces. Other pests, such as the cyclamen mite, which live in the crown and folded leaves, are not affected unless the insecticide penetrates down through the canopy of leaves. To obtain good control, you must know where the pest lives at the time of the

treatment, and then apply the proper material at the proper place at the proper time. Otherwise the control is a waste of time and money. In fact, improperly timed or unneeded treatments can intensify pest problems by killing parasites and predators, and leaving the intended victims of the treatment unharmed.

### **How to detect pest damage**

When you have unhealthy strawberry plants in your field, you may sometimes have trouble ascertaining the cause. Improper growing conditions, plant diseases, or insects can all result in poor growth or death of the plants.

Generally, the best way to identify insect damage is to see the insect or evidence of its feeding. Usually you can see the pests feeding on exposed portions of the plants; even after they have disappeared, their damage remains plainly evident. Pests feeding on roots and crown cause a lack of vigor or a wilting of the plant. When confronted with such symptoms, dig up several plants and determine whether the damage is caused by pests. Since diseases and soil conditions are often more difficult to diagnose than insect damage, determine first whether insects or mites are the cause of your trouble.

In order that the information in our publications may be more intelligible, it is sometimes necessary to use trade names of products and equipment rather than complicated descriptive or chemical identifications. In so doing, it is unavoidable in some cases that similar products which are on the market under other trade names may not be cited. No endorsement of named products is intended nor is criticism implied of similar products which are not mentioned.

# Pests attacking leaves

## CYCLAMEN MITE

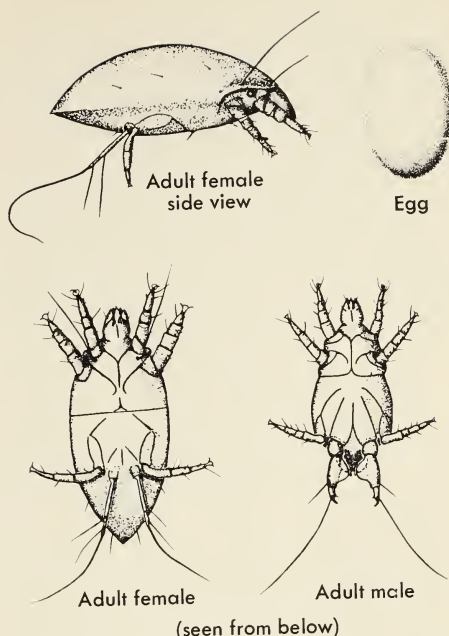
The cyclamen mite, *Steneotarsonemus pallidus* (Banks) is the most important pest of strawberries in California. Prior to 1946 it only occasionally did serious damage. Since then it has increased rapidly and today occurs in nearly all strawberry-growing areas of the state. When abundant, it can severely reduce production. Reasons for its spreading are the increase of strawberry acreage, the susceptibility of the Shasta and Lassen varieties, and the introduction of several insecticides which killed its natural enemies. Damage by the mite becomes evident in May or June, and remains serious until the end of the growing season. Fields during the second year after planting are usually most severely affected.

### What the mites look like

The place to look for the mites is on young, folded leaves, along the midveins. They are so small that even the adult is visible only with a good hand lens or microscope. Mature mites are pinkish-orange and shiny. The hind legs are thread or whip-like in the female, and grasping or pincer-like in the male. Eggs are translucent, comparatively large, and often so abundant that they appear as a white mass along the midveins of the folded leaves. The immature stages, an active larva and immobile nymph, are translucent white.

### How they develop

In most areas of California the cyclamen mite spends the winter as an adult female, in protected niches around the crown of the plant. In heavily infested fields you may find them beneath the base of the leaf stems. In March and April, when the plants begin to grow, the mites start reproducing. Most females



The cyclamen mite is not visible with the naked eye; when mature, it is about 1/100th inch long.

move to the young, folded leaves to lay their eggs; as each leaf begins to open, the females move down to the next developing leaf bud. This gives the eggs and immature stages protection within the folded leaves.

Under favorable conditions, each female lays about 90 eggs of which some 30 per cent develop into females. During the summer the mites grow from eggs to adulthood within two weeks; they keep multiplying throughout the summer. Because they mature so quickly and have such a long egg-laying period, you can find all stages of development throughout the period of reproduction. For the same reasons, populations can increase very rapidly under favorable conditions. Cool weather in October greatly reduces reproduction, and by November most of the females hibernate around the crown of the plant.

## Damage

The first symptoms of cyclamen-mite feeding are a slight retardation of growth and a somewhat roughened and off-color appearance of the leaves. Soon the leaves become crinkled and the leaf stems do not lengthen so that the plants take on a characteristic flat look.

When infestations become very high, the new leaves are severely stunted and crinkled, and form a more or less compact mass in the center of the plant. Usually at this time the leaves are brownish green. When infestations become heavy, the mites move out and feed on the flowers, causing them to wither and die. Fruit on infested plants is dry and somewhat dwarfed, and the seeds stand out on the flesh of the berry in a characteristic manner.

## What climate they prefer

The cyclamen mite thrives during periods of moderately high temperatures such as those in the Santa Clara Valley. Low temperatures during the winter stop reproduction but never kill all the females hidden down in the crown of the plant. High temperatures, such as those in Fresno during the summer, retard reproduction but do not stop survival of the mite. The central coast is too cool for

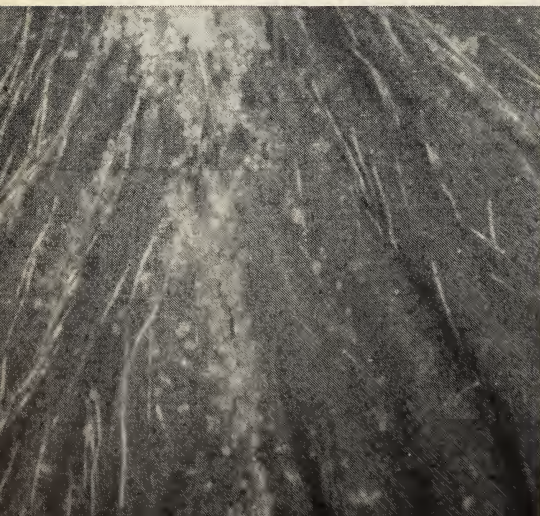
maximum reproduction but farther inland, as temperatures increase rapidly, conditions for the pest are almost ideal.

High humidity is essential for survival of the cyclamen mite. Nevertheless, dry atmospheric conditions have little effect on the mites because they are always provided with suitable humid conditions within the young, folded leaves. Under greenhouse and lathhouse conditions the cyclamen mite can survive on a variety of ornamental plants. Under outdoor conditions, strawberries seem to be the only suitable host because the other plants do not provide protection from drying. Because the mites are so susceptible to drying, control by drying out the fields has been tried. In extreme cases, even burners have been used; however, while numerous mites were killed, they always returned by the time the plants recovered.

## How the mites spread

Unless a new field is isolated many miles from other infested fields, it is certain to become infested with the cyclamen mite. Pickers, workers, bees, and birds all can spread the pest over long distances. Freezer trays, likewise, seem responsible for spreading the mites, and for even greater distances. In exceptional

Left: Cyclamen mite eggs concentrated along the midvein of a strawberry leaflet. Right: Injury caused by the cyclamen mite on strawberries. Note crinkled leaves and stunted new growth in the center.





cases it may be worthwhile to fumigate the trays with methyl bromide or to dip them in a hot-water bath. Either method is expensive and time consuming because of the large number of trays involved. Furthermore, such mite control on trays will prevent introduction of the pest only to those fields which are far enough removed so all other possible means of introduction are eliminated.

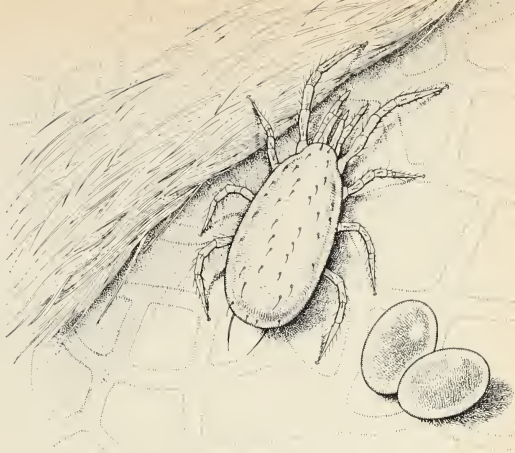
### Natural enemies

A very effective predatory mite, attacking the cyclamen mite in California, belongs to the genus *Typhlodromus*. It feeds on all stages of the cyclamen mite but not on other pests or on the strawberry plant. When abundant, this natural enemy can reduce a cyclamen mite population to a very low level and maintain them there for the entire life of the planting if not destroyed by chemical treatments harmful to it.

The two important predators, *Typhlodromus bellinus* Womersley and *Typhlodromus reticulatus* Oudemans, are somewhat larger than the cyclamen mite on which they feed, but you still cannot see them readily without a hand lens. They are rather flat, pear-shaped, rapidly moving mites that vary in color from translucent white to pinkish. They can be distinguished from *Typhlodromus occidentalis* Nesbit (a common predator on the two-spotted spider mite, see page 10) by their rapid movements, the inconspicuous spines on their backs, and their presence on the folded leaves (and not, as the other, on the underside of opened mature leaves).

The *Typhlodromus* species never become abundant in a strawberry field. Even at their peak, just before decimating a high cyclamen-mite population, you will hardly find more than one mite per leaflet. After they have reduced the cyclamen mite to a level of equilibrium, you will have to examine many leaves to detect one predator.

The predator cannot breed without



*Typhlodromus bellinus*, one of the important natural enemies of the cyclamen mite can only be seen with a magnifying glass.

cyclamen mites to feed on, and therefore is not present in a strawberry field until the cyclamen mite becomes established. Since it takes time for the predator to enter a field and spread from plant to plant, the cyclamen mite may do considerable damage before the predators can control it. Release of predators into young fields during late summer has shortened this lag and greatly reduced damage the following year.

Sometimes this predator becomes established but fails to bring about control because of the harmful effects of certain pesticides. Organic phosphates such as parathion and malathion nearly exterminate this predator and consequently cause an increase in the cyclamen-mite populations. Fortunately other pesticides can be used to control the various strawberry pests which do not have such a devastating effect on the *Typhlodromus*. Many of the acaricides can be used against the two-spotted mite without harm to the predatory mites.

### Control

Use uninfested nursery stock. California nurseries are generally free of the cyclamen mite, and treatment of the

nursery plants is usually not warranted. Where plants are known to be infested, treat them in hot water at 110°F for 30 minutes, or fumigate with methyl bromide using 2 pounds per 1,000 cubic feet when the temperature is close to 70°F.

Once the mites become established in a field, they multiply rapidly, and removal of infested plants or spot treatment is of little value.

Chemical control of the cyclamen mite is difficult because

- the mite is relatively resistant to most pesticides
- the pest remains in the folded leaves and crown where it cannot be reached easily with a toxic material
- the mite multiplies so fast that the initial kill must be exceedingly high if control is to last for a practical length of time
- the danger of residue severely restricts the types of pesticides and the times of application, as the picking period lasts from April through November.

To control the cyclamen mite, a relatively large amount of poisonous material, in liquid, solid, or gaseous form, must be brought in contact with the individual mites. Ordinary dusting methods (hand duster or airplane) are not effective, as it is difficult to get the dust in contact with the mites and a thin film of dust cannot give off enough vapor concentration to bring about control.

Low-gallonage sprays, likewise, cannot contact all the mites, and only limited amounts of vapor reach the pests. Such sprays will be effective only after a suitable systemic pesticide has been developed. Research is looking for effective systemic materials which penetrate through the leaf surface and then move to inaccessible portions of the plant. So far, none has proved effective against the cyclamen mite.

The only alternatives remaining are high-gallonage sprays, crown treatment

with dusts, or fumigation under a tarpaulin. For the latest recommendations consult your Farm Advisor.

## **TWO-SPOTTED SPIDER MITE**

The two-spotted spider mite, *Tetranychus telarius* (Linn.), commonly called red spider, is present wherever strawberries are grown in California; if left uncontrolled, it may severely inhibit strawberry production everywhere, but is most destructive in the warm interior valleys.

Of the main California strawberry varieties, the Shasta is most susceptible to the two-spotted mite. The Lassen is less susceptible but also may be seriously affected by the pest.

### **What the mites look like**

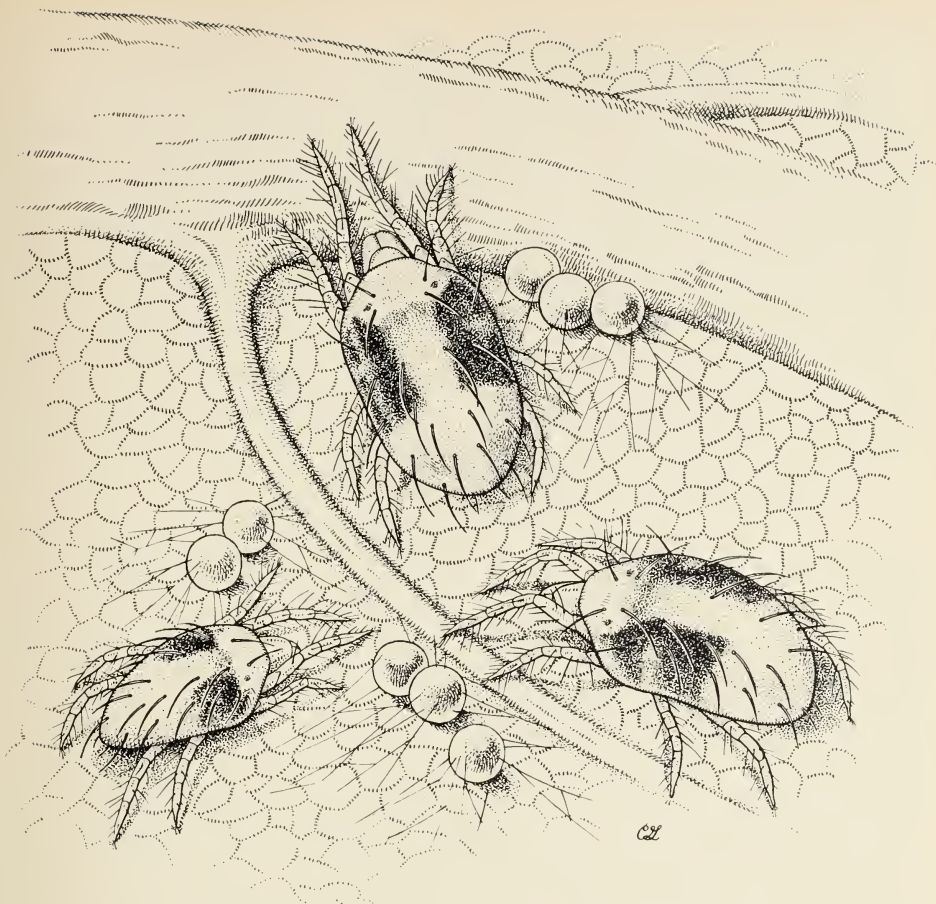
The adults of the two-spotted spider mite are eggshaped, generally yellow or greenish, with a tendency to turn a bright orange during the winter. On each side of their bodies are one or more dark, almost black spots. You can find them on the underside of mature strawberry leaves.

The eggs are very conspicuous, relatively large and round; they are clear and colorless when laid but become pearly white as incubation progresses. There are three distinct immature stages in the development of the mite, each stage becoming increasingly similar to the adult. When abundant the mites produce a noticeable amount of webbing on the underside of the leaves.

### **How they develop**

The two-spotted mite normally overwinters as an adult female; however, in mild areas and warm years the pest often reproduces on strawberries throughout the winter. In the spring they build up rapidly and are a serious threat from March through May. Since they grow from egg to adult within less than two weeks during the summer, and females lay between 50 and 100 eggs, two-spotted





The two-spotted spider mite which can be found in large numbers on the undersides of mature strawberry leaves.

mite populations can flare up rapidly. During the summer the attacks become less severe, probably because the strawberry plant becomes less favorable as a host; yet, the mite must be regarded as a potential pest throughout the year.

### Damage

Early in the spring the two-spotted mite begins feeding, in restricted colonies, on the underside of the newly produced leaves. This may result in small yellow spots on the upper surface of the leaves, but such symptoms do not show up in all cases, nor at later periods in the year.

Characteristic symptoms are, at first, brownish dry areas on the lower leaf surfaces where the mites have been feeding. Later, as the mites spread out, the entire lower leaf surface may become dry and brown. Heavily infested plants look dry and stunted, and the sparse new growth is somewhat yellowish and distorted. Plants that remain heavily infested become severely weakened and on occasion may be killed.

Damage is often first apparent in dry areas of a field. Plants suffering from lack of water seem more favorable to the mites, and unthrifty plants cannot withstand attack nearly as well as vigor-

ously growing plants. For reasons not entirely understood, the two-spotted mite is often a serious pest on plants covered with dust as, for instance, along unoiled roadways.

### How the mite spreads

The two-spotted mites survive on many host plants including deciduous fruits, vegetables and weeds, particularly morning glory. Since the mites are wind borne by the webbing they produce, newly planted strawberry fields soon become infested. Whether the mites build up to the point of damage, usually depends more on favorable conditions in the field than on whether the mites are introduced into the area.

### Natural enemies

By far the most important natural enemy of the two-spotted mite is the mite, *Typhlodromus occidentalis* Nesbitt. These mites can be distinguished from the cyclamen-mite predators (belonging to the same genus) by their distinct spines on their backs and by their less rapid movement. In addition, you will usually find them with two-spotted mite colonies on open mature leaves, while the cyclamen mite predator is seldom found there.

*T. occidentalis* is often present in strawberry fields and can control the two-spotted mite, but in the spring often lags so far behind the pest that it cannot prevent the build-up of damaging populations. Nevertheless, since this predator is not seriously affected by many of the

pesticides, including the phosphates used for mite control, it often helps maintain control after high populations of the pest have been suppressed by chemicals.

Another predatory mite, *Phytoseiulus macropilis* (Banks), occasionally occurs on strawberry early in the spring. It is striking in appearance (bright red color and round body), yet of limited value because it is easily killed by most of the pesticides used on strawberries.

Other natural enemies of the two-spotted mite are:

Anthocorids, mainly *Orius tristicolor* (White), a small black bug that is orange when immature, and which is often seen in the flowers.

*Stethorus* sp., small black ladybird beetles, which are gray when larvae.

The six-spotted thrips, *Scolothrips sexmaculatus* Perg., which are white with black spots on their wings.

The small staphylinid beetle, *Somatium oviformis* (Casey).

### Control

High populations of the two-spotted mite should not be left uncontrolled even during the winter. On the other hand, dusting for insurance or merely because a few mites are present is wasteful and even harmful (see box). During the spring, especially before harvest, start control when you find as few as one or two mites per leaflet; however, during the summer and fall, do not treat fields until populations become considerably higher—five or ten mites per leaflet. Although relatively good acaracides are now available for use on strawberries, successful control still depends on thorough underleaf coverage, and very often more than one application is necessary. Generally, dust applications give better underleaf coverage than sprays; however, this merely reflects the inadequacy of much of the spray equipment used on strawberries.

Prior to harvest, select acaracides which either kill the eggs or have a suf-

**WARNING:** Indiscriminate use of insecticides, particularly materials such as DDT, TDE, and phosphates, tends to increase the severity of attack by the two-spotted mite. This increase is partially due to its killing off predators, but seems also to be brought about by some unknown stimulating effect acting on the two-spotted mites themselves.

ficiently long residual effect to kill the immature mites as they hatch from the eggs. Occasionally plants during the early spring form such a compact canopy close to the ground that you have to use a material with a fumigant action. In such cases repeated applications are generally necessary.

During harvest it is often impossible to use materials which will give control of the eggs so you have to make two applications to obtain adequate control. Under such circumstances wait with the second application until all the eggs have hatched, but do not delay to the extent that individuals hatching from the eggs have time to mature and lay additional eggs. During warm weather keep the treatments about six days apart, but extend this interval to about two weeks during cooler weather.

### STRAWBERRY APHID

By far the most abundant aphids in strawberry fields are the strawberry aphids, *Pentatrichopus fragaeifolii* (Cockereil) and *P. thomasi* Hill Ris Lambers. The two are almost indistinguishable from each other. They thrive in cool weather (particularly on the coast) and may build up to high numbers during the spring and cause severe damage to

strawberries. When present in low numbers, they have little direct effect on the plants, but even one individual can transmit virus diseases from one strawberry plant to another.

Generally the Shasta variety is more seriously attacked by the strawberry aphid than the Lassen. Although the pest has been found on roses, *Potentilla*, and wild strawberries, these hosts do not add significant numbers of aphids to existing populations on cultivated strawberries. Nevertheless, if you grow nursery plants in isolated areas to avoid virus diseases, watch wild hosts as a potential source of virus contamination.

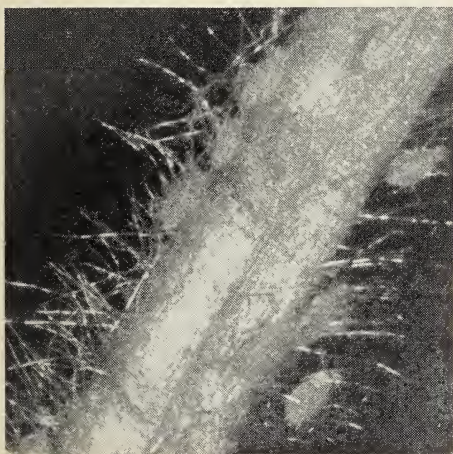
### What the aphids look like

During the spring you can see the strawberry aphid concentrated on the stems and leaflets of young developing leaves, and also along the veins of old mature leaves. The pest is moderately small, yellow to whitish, with relatively long antennae and well developed cornicles. The body has a dullish appearance. Immature forms are smaller but otherwise look like the wingless adult females. Winged females of this same aphid, on the other hand, have a very different appearance. They are a rather shiny, yellow-green, with extensive black markings on head and body.

### How they develop

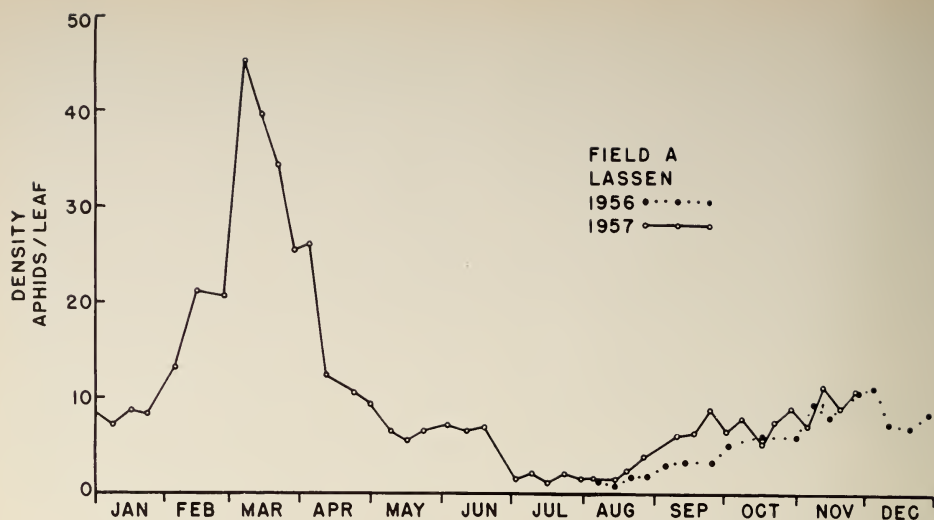
Under California conditions the strawberry aphid reproduces throughout the year. The pests reach their peak in March then decline to a low level during the late spring and summer, except in the cool coastal areas where moderately high populations may persist throughout the year. In the fall aphid numbers begin to increase again, but cold weather usually arrests this build up before populations become exceedingly high.

Winged individuals, too, reach their peak in late March when about 40 per cent of the maturing individuals have wings. The proportion of winged indi-



Strawberry aphids feeding on the stem of a strawberry leaf.





The seasonal abundance of the strawberry aphid, San Jose.

viduals then drops rapidly in May, reaches a low in summer, climbs to a moderate peak in October, and declines in November until only a small number of winged individuals are produced through the winter.

### Damage

Strawberry aphids, when present in large numbers, weaken strawberries by sucking up plant juices. In the process of feeding they excrete large quantities of honeydew which makes the fruit and leaves sticky, and also promotes the growth of a black, sooty fungus. This honeydew and sooty mold, although not very harmful to the plants, can make picking difficult and may make the fruit unsalable.

In addition to this direct damage, the strawberry aphid carries several virus diseases of strawberries. Although the symptoms of these diseases are not clearly evident on Shasta and Lassen varieties, it is apparent that many strawberry fields decline because of the effect of these viruses. Any one component by itself may not destroy a plant, but the cumulative effect of several may be very serious.

### Natural enemies

Natural enemies which help depress aphid populations include ladybird beetles, syrphid flies, lacewings and several parasitic wasps. In addition, a fungus disease often attacks after spring rains and brings about significant population reductions. Although all of these agents seem to be important in determining the time and rate at which populations decline in the spring, the main cause of low populations through the summer seems to be a change in the physiology of the strawberry plants which makes them less favorable for the aphid.

### Control

Strawberry plants can tolerate rather high populations of the strawberry aphid without serious direct injury. On the other hand, one aphid flying through a field can infect many plants with virus diseases.

To prevent injury from direct feeding and the secretion of honeydew it would be necessary to control when there are 10 to 20 aphids per leaflet. Before applying control measures, however, consider the possibilities that pest populations

may decline in the near future because of hot weather or natural enemies.

To prevent the spread of strawberry viruses it is necessary to keep aphid populations at a much lower level than for prevention of direct injury—less than one aphid per leaf. Since winged forms of the aphid are probably most important in spreading virus diseases, it is especially desirable to have thorough control during the periods of maximum wing formation—late March and October. Effective virus control can be accomplished only by an intensive control program and, even then, the beneficial effects can be nullified if winged aphids are allowed to develop in surrounding fields.

When plants are grown for nursery stock, isolate the plantings and carry out an intensive aphid control program. On the other hand, when strawberries are grown for fruit production it is not always practical to attempt virus control by controlling the aphids. The fields are often very close to neighboring fields, and only few insecticides exist that can be used during the long picking season. Before you undertake a virus-control program, determine whether it can be carried out in an effective manner. Much effort is wasted if during any one period large numbers of aphids are allowed to fly into the field. The most important measure for virus control is the selection of virus-free planting stock.

The strawberry aphid can be controlled with most of the insecticides that are normally effective against other aphids. For maximum control, as is necessary for virus control, select the most highly effective materials. Since this aphid tends to hide between the leaflets of folded leaves, use an insecticide with a high fumigant action or a long residual effect. Systemic materials are also highly effective.

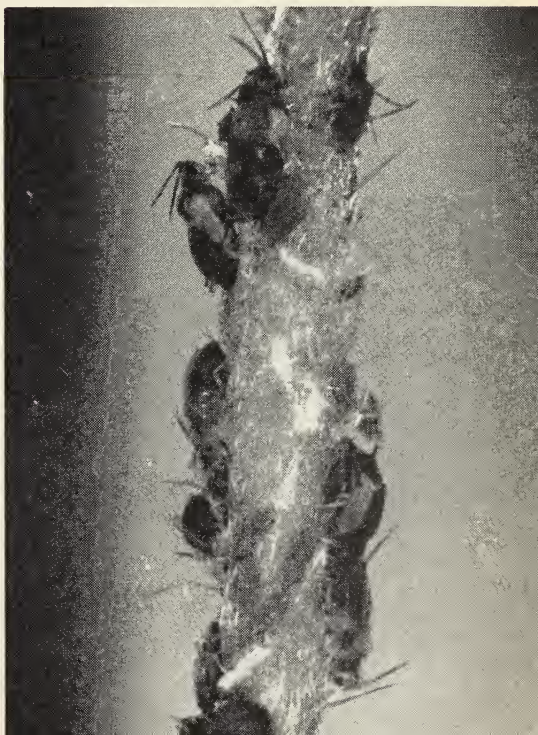
## STRAWBERRY ROOT APHID

The strawberry root aphid, *Aphis forbesi* Weed, mostly attacks backyard strawberries, but occasionally injures localized areas of commercial strawberry fields. In California, the strawberry root aphid attacks the leaf stems and newly developing leaf buds. You can distinguish this pest from the strawberry aphid by its short egg-shaped form and bluish green color.

In California, at least in the milder areas, the pest continues to reproduce without mating throughout the winter. There are many generations per year. Most of the adult females are wingless, but during the summer and fall winged individuals are produced. In cooler regions, sexual males and females are formed in the fall; they mate and produce the overwintering eggs.

### Damage and control

The strawberry root aphid concentrates around the crowns of the plants where it feeds on the leaf stems and young developing leaf buds. Through its sucking of plant juices it seriously



Strawberry root aphids on the stem of a strawberry leaf.



OUTSIDE CALIFORNIA the strawberry root aphid is a more serious pest, particularly in the Eastern United States. Where the cornfield ant is present, this ant establishes and tends the aphids on strawberry roots where they may cause serious damage and even kill the plants. Aphid control in this case is facilitated by controlling the ant. Insecticide is applied to the beds when there is no fruit on the plants.

weakens plants and causes them to look dry and unthrifty.

The pest can be partially controlled by dusting with commonly used aphicides. A better control can be obtained with a comparatively high-gallonage spray because of the aphid's crowding around the crown of the plant. Since the aphids occur in localized areas, you can often spot-treat infested areas.

### STRAWBERRY WHITEFLY

The strawberry whitefly, *Trialeurodes packardii* (Morrill), and the iris whitefly, *Aleurodes spiroeoides* Quaintance, both attack strawberries and cause damage similar to the strawberry aphid. They suck juices from the plants and excrete large quantities of honeydew on which sooty mold grows. They are not, however, carriers of virus diseases. Unlike

the strawberry aphid, whiteflies are favored by high temperatures, and consequently are more abundant in the warm interior valleys.

### What whiteflies look like

The adults are small ( $\frac{1}{16}$  inch long), moth-like, insects with inconspicuous yellow bodies and prominent white waxy wings. You can see them swarm around the plants when they are disturbed. Adults of the iris whitefly have two faint black spots on their fore wings. Immature stages live on the undersides of the leaves and resemble scale insects because of their flat and oval shape. They are translucent, pale yellow, or whitish. Immature stages of the strawberry whitefly can be readily distinguished by the prominent white fringe of wax which is absent on the iris whitefly.

### How they develop

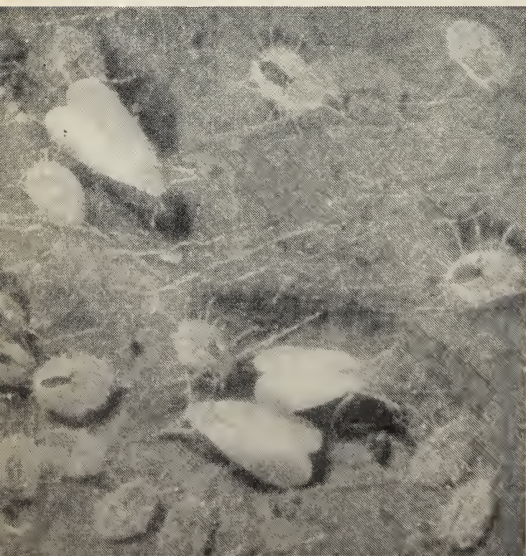
The strawberry whitefly overwinters in the immature stage on the leaves of strawberries. The adults emerge early in the spring and immediately begin laying their eggs on the undersides of the leaves. Egg laying and development of the immature forms takes place throughout the warm months of the year. Development from egg to adult requires four or five weeks; thus, there are several overlapping generations during the year.

### Damage and control

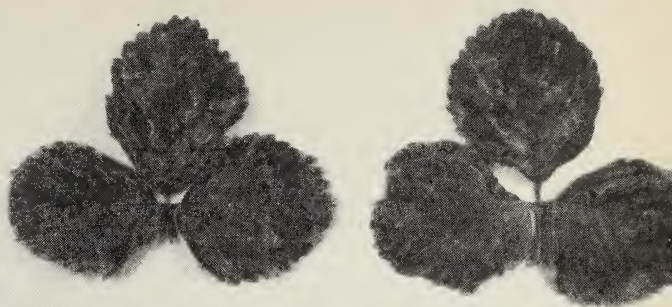
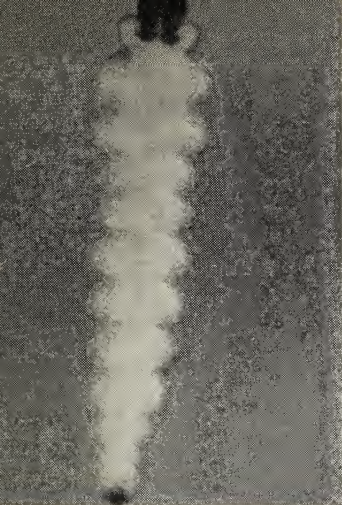
Whiteflies are always present in a strawberry field, but rarely build up to damaging numbers. Parasites and predators seem to hold down populations, and topping of the plants in the spring helps reduce overwintering populations. The Lassen variety is somewhat more susceptible to damage than the Shasta.

Control may not be necessary even though adult whiteflies are very conspicuous in a strawberry field. Since the

Strawberry whiteflies on the underside of a strawberry leaf.







Left: A strawberry leaf miner larva removed from its mine in the leaf. Right: Strawberry leaves mined by the miner.

immature forms excrete most of the honeydew, watch the undersides of the leaves for the extent of the infestation. Generally populations are very uneven; only certain areas or borders of a field may have sufficient numbers to cause economic damage.

Control is difficult; undertake it only when honeydew becomes apparent. The immature forms of the whiteflies can be killed only with completely wetting sprays. Adults can be controlled more readily, but since they emerge over several weeks, repeated applications are necessary to materially reduce populations. Residual insecticides which would kill the adults for several weeks are seldom practical because of the resulting residue on the fruit.

### STRAWBERRY LEAF MINER

Most of the time the strawberry leaf miner, *Tischeria* sp., is present in California strawberry areas in such low numbers that few people notice the pest. At times, however, it increases to the point that it becomes of concern to growers, and occasionally leaf miners are so numerous that they cause significant leaf injury.

### What the leaf miners look like

The adult leaf miner is a slender, metallic gray moth, so small it is rarely noticed—about  $\frac{1}{8}$  inch long. The larvae, readily seen within the leaf mines, are flat, distinctly segmented, green caterpillars with dark brown heads. They overwinter within the mined leaves, pupate in the spring and emerge as adults. Soon after mating they lay eggs on the older leaves which are most favorable because of their greater thickness. There are numerous generations during the year.

### Damage and control

Leaf-miner larvae bore between the two epidermal surfaces of the leaf and devour the internal tissues. As they grow they destroy a wider and wider area, making the mines look like expanding blotches. Small numbers of mines have little effect, but large numbers can seriously reduce the effective leaf surface of attacked plants.

The pest is generally held under control by numerous wasp-like parasites which lay their eggs on the larvae within the mines. Occasionally, the leaf miner builds up to damaging numbers, but

chemical control is of questionable value. Not only do all of the insecticides which give control leave a residue on the fruit for several weeks, but insecticides often kill more parasites than leaf miners, and consequently, result in a build up of the pest after a very temporary reduction.

Since the leaf miner overwinters within the leaves, populations are reduced considerably by topping the leaves in the spring. Burning of the old topped leaves, as was commonly practiced in the past, seemed to be more effective in destroying the larvae than mulching of the leaves with a mechanical beater.

### SPITTLEBUGS

The meadow spittlebug, *Philaenus leucophthalmus* (Linn.), a serious pest of strawberries in Oregon, Washington and other parts of the country, is rare in California; damaging populations never

seem to develop. When present in large numbers spittlebugs weaken the plants and distort the leaves and fruit. The pest is sometimes introduced on nursery stock from areas where spittlebugs are a problem. Conditions in California are generally so unfavorable that populations either die out, or remain at a very low level for several years. Spittlebugs overwinter as eggs on the stems of plants. They hatch in the spring about the time the blossoms are first evident, and continue to develop until they transform to adults in May. There is but a single generation each year.

You can recognize spittlebugs by the mass of froth they secrete around their bodies. Within the froth you may find white nymphs with dark eyes and distinct legs. The adults are somber brown, look like overly robust leafhoppers, and are about  $\frac{1}{4}$  inch long.

## Pests attacking flowers and fruit

### LEAF ROLLERS ON STRAWBERRIES

Numerous species of leaf rollers and leaf tiers attack strawberries in California. Most of them have similar habits

There are a number of leaf rollers attacking strawberries in California; some are specific to strawberries, others primarily attack other crops and only occasionally build up to damaging numbers on strawberries. Among the latter are the oblique-banded leaf roller, *Archips rosaceana* (Harr.), the orange tortrix, *Argyrotaenia citrana* (Fern.), the cyclamen leaf roller, *Clepsis buskana* Keifer, the celery leaf tier, *Udea rubigalis* (Guen.), and the omnivorous leaf roller, *Platynota stultana* Wlsh. These species are not discussed in this circular; their life histories and controls are similar to the more specific leaf rollers that are treated here in detail.

of rolling the leaves and feeding on the foliage and, when disturbed, wiggling backwards very rapidly. Their feeding on the leaves, however, is far less important than the trouble they cause when they feed on the berries; they penetrate into the fruit where they may remain until the berries are processed for canning or freezing. When this happens the caterpillars often stay undetected until the packaged product is opened for inspection or consumption.

### GARDEN TORTRIX

The garden tortrix, *Ptycholoma peritana* (Clem.), is the most common leaf roller in strawberries. Although the moths can be readily seen flying in the evening or when disturbed, the larvae often remain undetected because their peculiar habits make them very inconspicuous.

## What the tortrix looks like

The buff-brown moths of the garden tortrix are about  $\frac{1}{4}$  inch long. Their characteristic bell-shaped wings are held flat over their bodies so the moths look considerably broader than the strawberry leaf roller. Each of the forewings is marked with a diagonal stripe and a marginal spot of dark brown.

The slender larvae are almost  $\frac{1}{2}$  inch long when mature. They have gray-green bodies and light brown heads; each side of the head is marked with a small but distinct spot of darker brown.

## How they develop

The garden tortrix overwinters as larvae and pupae in the trash around the base of the plant. You may see a few adults on warm days in the winter, but usually not many until March or the beginning of April. The eggs are laid on the older leaves in scale-like, transparent, flat masses of about 18 eggs. After hatching, the larvae, instead of feeding on the leaves, move down to the trash that accumulates around the crown of the plant. Here they feed on the dead and decaying leaves, and construct shelters by tying together bits of trash. There are about four generations per year, but usually all stages are present so that it is very difficult to detect distinct generations.

## Damage

Most of the time the larvae feed on the dead and decaying leaves and fruit where they cause no significant damage. Occasionally, however, high populations develop and the larvae, after having consumed all decaying organic material, feed on the young leaves and fruit. Under such circumstances the young leaves may be completely killed and the berries riddled with shallow holes usually surrounded by large amounts of webbing. Such holes not only reduce the value of the fruit, but also allow fungi to enter and destroy the berries.



Moth of the garden tortrix.

A more serious problem is presented by the small percentage of larvae which remain webbed to the fruit during picking and processing and then become evident in the finished product. However, neither the attack on the fruit nor the contamination of the finished product are pronounced when pest populations are limited. But when populations become high, this pest can be a very serious problem.

## Control

Several wasp parasites are highly effective in controlling the garden tortrix. Often sizeable flights of the moths are followed by insignificant caterpillar populations because of the effect of these parasites. At times the only indication that the garden tortrix has been present will be the numerous parasites swarming around the strawberry plants. Because parasites are so effective, do not start control measures merely because you see moth flights.

Chemical control of the garden tortrix is difficult because the larvae live down in the trash beneath the protective canopy of strawberry leaves. Control by residual materials will depend on the



amount of insecticide that can be made to penetrate through the canopy. Dust applications are generally inadequate because only a small amount of insecticide will reach the caterpillars. To obtain good control, brush aside the leaves with a bar or chain in front of the spray nozzles and direct the spray through the opening made in the canopy.

### THE STRAWBERRY LEAF ROLLER

The strawberry leaf roller, *Ancylus comptana fragariae* (W. and R.), is not the most abundant nor serious leaf roller attacking strawberries in California, but it may cause considerable damage. It is restricted primarily to the central coast region. Other areas are probably too warm for the pest which is widespread across the northern United States and Canada.

#### What the leaf roller looks like

Moths of the strawberry leaf roller are active during the day, but remain inconspicuous because they hide beneath the leaves. You may notice them flying from one plant to another when disturbed. These small moths, about  $\frac{1}{4}$  inch

long, fold their wings in such a manner that they have a slender appearance. Their color is predominantly reddish brown, but on their backs they have a distinct pattern of wavy white lines.

The larvae are found within the folded, often partially dead leaves, which stand out conspicuously on the plants. They are slender, green caterpillars about  $\frac{1}{2}$  inch long when mature. Their heads are brown, and on the top of the back end of the abdomen they have noticeable dark brown markings which distinguish them from many of the other leaf rollers.

#### How they develop

The life history of the strawberry leaf roller is rather typical for many of the leaf rollers. They overwinter as larvae and some as pupae protected within the folded leaves. Early in the spring, about February or March, the moths emerge and lay their transparent, flat eggs on the undersides of the old leaves. The larvae, upon hatching, feed for a short time on the open leaves, but soon begin to fold the leaves. Pupation takes place within the folded leaves. There are about



Strawberry leafroller. Left: adult, right: caterpillar.

four rather irregular generations during the course of a year.

### Damage

Unlike many of the leaf rollers which attack a wide variety of crops, the strawberry leaf roller is restricted to strawberries, blackberries and raspberries. After folding the leaflets of strawberries they generally feed along the midvein until half of the leaflet is killed in a very characteristic manner. Such injury is only serious when very high populations are present. Because this leaf roller feeds mainly on the foliage and to a very limited extent on the fruit, moderate populations may remain undetected.

### Control

The common practice of topping and burning the leaves in the spring helps control the strawberry leaf roller by killing many of the overwintering larvae. Parasites, likewise, seem to be quite effective when pest populations become high in the spring.

Chemical control is difficult because the larvae are protected in the folded leaves, and only a limited number of materials can be used without leaving a residue on the fruit. Certain residual

materials will give control, but it takes time for the larvae in the folded leaves to contact the insecticide.

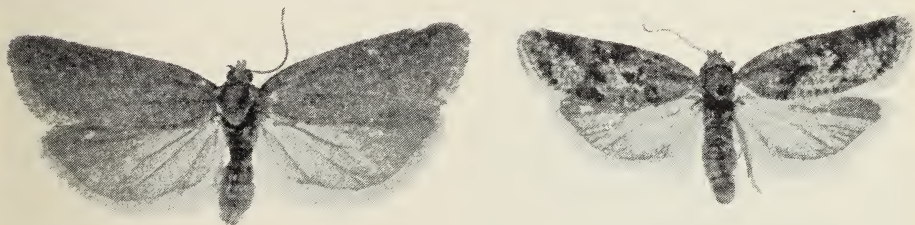
### OMNIVOROUS LEAF TIER

The omnivorous leaf tier, *Cnephasia longana* (Haw.), attacks strawberries only in limited areas of California (mostly in the San Francisco Bay Area and around Watsonville), but is a serious pest because it tends to bore into the fruit. Unlike the other members of this group, a high percentage of the larvae feed on the berries so that even low populations cause serious damage by contaminating the fruit to be processed.

### What the leaf tier looks like

The moths fly at night in about May, and can occasionally be seen when disturbed during the day. Generally they remain undetected because damaging populations are relatively low. The moths are about  $\frac{3}{8}$  inch long with buff brown or gray wings which are held so they roll down over the body to a considerable degree. Females can be distinguished from males because their wings look more mottled.

The full-grown larvae which are about  $\frac{1}{2}$  inch long can be distinguished from



Male (left) and female (right) of the omnivorous leaf tier.



Larvae of the omnivorous leaf tier.

the other leaf rollers by their robust appearance. The small larvae have white bodies and shiny black heads, whereas the nearly mature larvae have three rather distinct light gray stripes running down their backs, and their heads are light brown with dark spots on either side.

### How they develop

There is but a single generation of the omnivorous leaf tier each year. The adults fly in May and June. They lay their eggs on the bark of trees and other rough surfaces, such as fence posts and telephone poles. The eggs hatch in a short time, and the newly emerged larvae immediately spin small silken cocoons within which they remain inactive through the summer and winter. In February and March the small larvae spin silken threads which enable them to be carried by the wind to surrounding crops. Here the larvae mine the leaves for several weeks and then commence to web the foliage. It is at this time that they seriously attack the flowers and fruit of strawberries. After pupation within the webbed leaves (in May and early June) there is no further damage until the following year.

### Damage

Leaf damage is minor when compared with the harm done to the fruit. The larvae feed on the blossoms and green fruit and generally produce a considerable amount of webbing. As the fruit ripens the larvae tunnel into the berries, usually entering near the cap. These larvae within the fruit remain hidden until the berries are sliced, which occurs after the fruit has been sorted on the processing belt, and then later are detected in the processed package of fruit.

### Control

The omnivorous leaf tier often injures the same field year after year. Since it is wind-blown from oviposition sites, its distribution is often spotty even in the localized areas that are infested. A universal control program therefore is not warranted. On the other hand, where there is a history of a field or area being infested, it is essential to control the pest before damage becomes apparent.

The omnivorous leaf tier can be controlled with the proper insecticidal dusts, but it is at times difficult to contact the larvae with the chemicals. Not only do the small larvae mine the leaves, but when they get larger they web the foliage and thus effectively protect themselves. To prevent injury to the fruit, control the larvae when they are small; the most ideal time for this is when the larvae change from mining to webbing the leaves. This usually happens in early April—before insecticide residues are a serious problem.

### EUROPEAN EARWIG

The European earwig, *Forficula auricularia* Linn., a common pest of ornamental plants, is most abundant in the coastal areas of California. These pests which feed on grains, decaying vegetable matter and many plants, are found during the day hidden in cracks and crevasses or under trash. Their presence on





The European earwig.

strawberries is often associated with trash-filled ditches in which they may become exceedingly abundant.

### What earwigs look like

Earwigs feed at night and can be found with difficulty hidden around the crowns of the plants during the day. They are slender, brown insects, about  $\frac{1}{2}$  to  $\frac{3}{4}$  inch long. You can recognize them by the conspicuous pair of pincers that are attached to the back end of their abdomen. The wing covers of the adults are short and leathery.

There is only one generation of earwigs each year. The eggs are laid in clusters in the soil from December through February, and the pest becomes most destructive as the nymphs approach maturity from April through July.

### Damage and control

Earwigs do little or no damage to strawberry plants, but they do attack the fruit. Their feeding results in rather small deep holes in the fruit which can

only be distinguished from slug damage by the absence of slime.

To control earwigs, destroy rubbish near strawberry fields. You may spray ditch banks and surrounding areas with an insecticide to reduce populations, but usually only moderate control can be expected. To control earwigs within a field, it is usually most practical to apply baits over the tops of the beds. These baits, which are available commercially, generally contain bran, fish oil and sodium fluosilicate. Several applications are necessary to obtain control.

## CUTWORMS

A diverse group of cutworms may attack strawberries. Occasionally they damage young plants by cutting them off at the base, and on older plants they feed on the foliage with rather minor consequences. Their greatest damage results from their feeding on the ripe fruit and making large holes in the berries.

### What cutworms look like

Cutworm adults are large moths, usually brown or gray, about  $1\frac{1}{2}$  inches long. They are night fliers, often called "millers," and commonly attracted to lights.

The shiny, fat caterpillars are nearly  $1\frac{1}{2}$  inches long and either mottled brown or gray. They feed at night and can be found hidden beneath the plants during the day.

Adult cutworm moth.



## How they develop

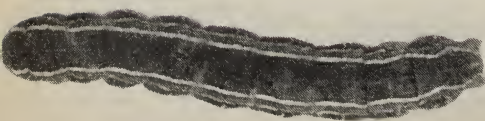
Most cutworms in strawberries overwinter as immature larvae. They mature as the weather warms up, pupate in the soil, and emerge as adults early in the spring. There are several generations each year.

Cutworms generally feed on grasses and cultivated crops. They are favored by cool weather but may be found throughout the year, particularly in the cooler areas. Since there are only a limited number of hosts in the late summer and fall for the moths to lay their eggs on, they tend to move into strawberries at this time. Damage from the resulting larvae may become evident later in the same year or not until the following spring.

## Damage

Cutworms make rather pronounced holes in the fruit of strawberries. These holes are somewhat larger than those made by earwigs, and there is no webbing or slime produced as in the case of the leaf rollers and slugs. Since each cutworm feeds on a number of berries on one or several plants, damaged berries tend to be concentrated in localized areas. This helps distinguish their feeding from salt-marsh caterpillars which forage over a wide area when mature.

Western yellow-striped armyworm.



## Control

Proper care of strawberry plantings helps reduce cutworm populations. Weedy fields tend to attract more moths to lay their eggs. A thorough job of topping the plants in the spring exposes and kills overwintering larvae.

Early in the spring cutworms can be controlled by applying comparatively high dosages of DDT or toxaphene. Control with these materials is only practical when there are a limited number of leaves on the plants; they cannot be used after the fruit begins to form which is usually when infestations become apparent. During the picking season bran baits containing DDT or some other poison will give partial control.

## THE WESTERN

### YELLOW-STRIPED ARMYWORM

The western yellow-striped armyworm, *Prodenia praefica* (Grote), from time to time causes damage to strawberries. This insect, most common in the Central Valley, feeds on many crops, especially alfalfa, and periodically becomes very abundant. It is during these outbreak years that it damages strawberries, primarily in the interior valleys but to a certain extent also in the coastal regions.

### What the armyworms look like

The adults of the yellow-striped armyworm are brown "millers," or moths which are difficult to distinguish from adult cutworms. The caterpillars are characteristically velvety black with several yellow or whitish lines running down their sides, but there is considerable variation so that brown and even tan individuals may be found with few or no lateral stripes.

### How they develop

The pest overwinters as pupae in the ground. The moths emerge early in the spring, about February, and lay their eggs in hair-covered masses on the leaves



of plants. There are about four generations per year, with the larvae disappearing in the latter part of September. The moths of the second and third generation are most likely to fly into strawberry fields and lay their eggs on the foliage.

### Damage

The armyworms, as the name implies, may invade fields in large numbers. When the caterpillars invade strawberries, generally from cut alfalfa, they may completely devour all of the foliage. More commonly, a few moths lay their eggs on the strawberries and the hatching larvae spread out through the field. They feed with minor consequences on the leaves, but cause serious injury by eating holes in the fruit. Occasionally, caterpillars remain in the berries and find their way into the frozen product.

### Control

When armyworms are known to be abundant in surrounding crops you can prevent them from migrating into your strawberries by placing an 8 inch wide barrier strip of some persistent insecticide, such as DDT, along the margin of the strawberry field that faces the infested crop. If possible, place the insecticide in a shallow trench: this will cause the caterpillars to repeatedly roll back into the insecticide.

Armyworms distributed throughout a field are difficult to control because of the residue problem. The persistent insecticides, such as DDT, will give control, but there are limitations on when these materials can be used on strawberries.

### SALT-MARSH CATERPILLAR

The salt-marsh caterpillar, *Estigmene acrea* (Drury), commonly known as "woolly bear caterpillar," attacks many truck and field crops, and can cause severe damage to strawberries. Generally it is not found in damaging numbers until the late summer and fall. This pest periodically becomes abundant and then in turn is reduced to low levels by parasites.

### What the caterpillars look like

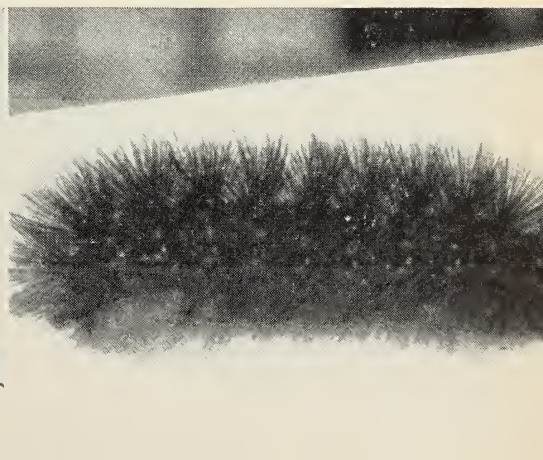
The adults are white moths with orange abdomens and black spots on their wings. Males differ from females by having their hind wings orange. The caterpillars are at first very hairy and gray; but when mature they are predominantly black with cinnamon red or tan hairs on the sides. They are almost two inches long when mature.

### How they develop

This pest overwinters as a mature caterpillar in trash and other protected places. They pupate in the early spring

Left: Salt-marsh caterpillars feeding on the underside of a strawberry leaf.

Right: Mature salt-marsh caterpillar.





and lay their round shiny eggs in neatly arranged clusters on the undersides of the leaves. There are several generations during the course of a year.

### Damage

When salt-marsh caterpillars first hatch, they remain clustered and feed on the undersides of the leaves where the eggs have been laid. They skeletonize the foliage of the plants immediately surrounding the egg mass. As they become larger they wander about and soon become scattered throughout the field. At this stage they eat holes in the leaves about  $\frac{1}{4}$  inch in diameter. This damage to the foliage is nearly always of minor importance, but they also have the habit of making superficial bites in the fruit which can be of serious consequences.

### Control

The salt-marsh caterpillar can be controlled with some of the persistent insecticides, but the dosages required are usually so high that they create a serious residue problem. Consequently, it is generally more practical to apply some of the highly volatile insecticides which, although they give only partial control, do not leave a toxic residue on the fruit. Sometimes it is practical to attempt spot treatment of the caterpillars while they are still skeletonizing the leaves, for at this time they are quite readily killed by a large number of insecticides.

### WESTERN FLOWER THIRPS

The western flower thrips, *Frankliniella occidentalis* (Perg.), may often be found feeding in strawberry blossoms. Flower thrips build up on alfalfa, weeds and other vegetation in the spring, and then move from these hosts when they are either cut or naturally dry up. When such vegetation is near strawberries, large numbers of thrips may take refuge in strawberry blossoms, where they are able to feed and reproduce.

### What the thrips look like

You may find the thrips by striking flowers against the palm of the hand. They are slender, very small insects—about  $\frac{1}{32}$  of an inch long when mature. The adults have feathery wings and vary in color from yellow to dark brown; the nymphs are white or yellowish with small dark eyes.

### What damage they do

Thrips feeding on strawberry blossoms cause the stigmas and anthers to turn brown and wither prematurely, but not early enough to prevent fertilization; thus, the feeding is of no consequence. Thrips have been falsely suspected of being the cause of irregular “catfaced” berries; but they just happen to be most abundant on berries at the time when “catfacing” is most serious. As the fruit develops, thrips feeding may cause a slight russetting of the fruit around the cap, but this injury likewise is seldom of economic proportions.

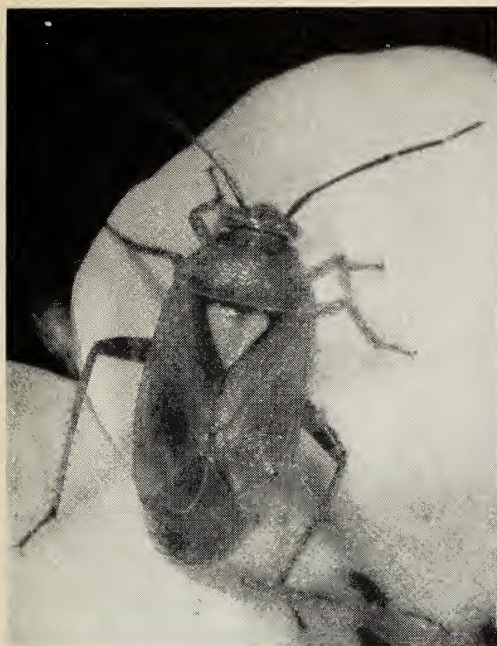
**Control** is not necessary as the thrips do not cause economic damage.

### LYGUS BUGS

Lygus bugs (*Lygus hesperus* kngt. and *L. elisus* Van Duzee) are common insects which prefer to feed on the reproductive parts of plants. Strawberries are not a preferred host of this pest, but when the weeds dry up in the late spring, the adults fly into strawberries and lay their eggs there.

### What lygus bugs look like

Adult lygus bugs are difficult to see because they fly and crawl rapidly when disturbed; occasionally you may see them resting on the flowers and foliage of strawberries. The adults are about  $\frac{1}{4}$  inch long, oval, and rather flattened. They are greenish or brownish, and have reddish brown markings on their wings. In the center of their back they have a



Left: Adult lygus bug on a strawberry flower. Right: Immature lygus bug showing the robust legs and absence of cornicles.

distinct, but small, yellow triangle which helps distinguish them from other insects. The immature forms are pale green and look somewhat like an aphid. They can be easily distinguished from the latter, however, by their more rapid movements and their more robust legs.

### Development

Lygus bugs overwinter as adults under leaves and trash. In the spring they feed and lay their eggs on a wide variety of crops and weeds. During the course of a year there are three or four indistinct generations; during the summer they develop from egg to adult in about 30 or 40 days.

Generally, adults far outnumber nymphs in strawberries because this is not a preferred host for reproduction, and populations usually decline as the season progresses.

### Damage

Lygus bugs are one of the causes of irregularly shaped or "catfaced" straw-

berries; another cause could be poor pollination which results in small undeveloped seeds. Lygus bugs damage the fruit by puncturing the individual seeds which in turn stops development of the berry in the immediate area. Since lygus bugs puncture large as well as small seeds there are always some deformed areas associated with large hollow seeds which is not the case with poor pollination. Very often a few of the hollow seeds will turn a straw brown which is a good indication of lygus-bug damage.

### Control

Do not attempt lygus-bug control with sprays or dusts merely because the berries are misshapen since there are many other causes of this condition. When berries become "catfaced," sweep the strawberries with an insect net and determine the abundance of lygus bugs. The exact number necessary to warrant control has not been determined, but unless one or two bugs are found in 10 sweeps it is very unlikely that they are





Catfaced strawberries caused by feeding of lygus bug.

causing any appreciable damage. In areas where lygus bugs have previously been a problem, check populations before damage becomes evident. Remember that irregularities in the ripe fruit arise from injury that was caused three or four weeks earlier; however, a close watch on the developing fruit will make

it possible to detect damage about one or two weeks after it has taken place.

## FALSE CHINCH BUG

The false chinch bug, *Nysius ericae* (Schilling), builds up on weeds and native vegetation during the spring and then moves to cultivated crops, such as strawberries, when the wild vegetation dries in May or June. Both adults and nymphs migrate in large numbers and feed on almost any plant which they encounter.

The adults are about  $\frac{1}{8}$  inch long with glassy wings folded flat over their light or dark gray bodies. The wingless nymphs are gray with a reddish-brown abdomen. False chinch bugs feeding on strawberries weaken and wilt the plants. The fruit on attacked plants is generally dry and shrivelled.

## Control

Weed control along roadways and borders of fields can be very helpful in preventing build up of the false chinch bug. Sometimes migrations can be prevented by burning surrounding vegetation as it dries. At other times it may be necessary to treat the weeds surrounding



Left: Adult of the false chinch bug. Right: Bordered plant bug.



strawberries with a residual insecticide. To be effective apply these materials at comparatively high dosages when the bugs first start to migrate. After the false chinch bug has entered a field, control is difficult for many of the insecticides that will give control will likewise leave a residue on the fruit.

### BORDERED PLANT BUG

The bordered plant bug, *Euryophthalmus convivus* (Stal.), is a common insect in the Central Valley where it feeds on many hosts. On strawberries the bugs are often seen wandering down the irrigation furrows. They are somewhat more than  $\frac{1}{2}$  inch long, predominantly black, with the margins of the body and portions of the legs a reddish-orange. The almost circular nymphs are bright metallic blue with a conspicuous red spot on their backs.

Bordered plant bugs overwinter as adults protected beneath trash. They move into strawberries in the spring and feed on the berries causing them to shrivel and dry. The eggs are laid in the spring and summer and the nymphs can be seen for a considerable period of time. Generally they are present in such low numbers that damage is not serious; however, they can on occasions cause economic damage. Since many of the insecticides that will control these bugs leave a residue on the fruit, it is difficult to devise a practical control.

### SLUGS AND SNAILS

Slugs and snails are well-known pests recognized by everybody. On strawberries they can be highly destructive because they feed on the fruit. They make small, moderately deep holes in the berries that can usually be recognized by the slime that is deposited on the surrounding fruit surface. Slugs and snails are most serious in the damp spring months, but along the coast they may persist as a pest throughout the year.

### Control

Slugs and snails may be controlled with poison baits. For best results scatter the bait over slightly damp beds in the evening. Several applications may be necessary for satisfactory control.

### SOWBUGS AND PILLBUGS

Sowbugs and pillbugs (*Porcellio laevis* Koch and *Armadillidium vulgare* (Latr.)) are dark gray or slate-colored animals that have seven pairs of legs and a series of plates on their backs. Since they breathe by means of gills, they are usually found in moist or damp places. Their food consists of decaying organic matter, but they may at times feed on the young tender growth of plants. They apparently do little damage to strawberries, but may occasionally be found feeding within holes in the fruit which were made by other pests.



Pillbugs.

# Pests attacking crown and roots

## STRAWBERRY CROWN MOTH

The strawberry crown moth, *Ramosia biblionipennis* (Bdvl.), attacks both strawberries and blackberries. The larvae, which cause all the damage, hollow out the crown of the plant so that all or a part of the plant is killed. Usually a few scattered plants in a field are attacked, but occasionally the crown moth builds up to such numbers that nearly all plants in a field are damaged.

### What the crown moths look like

You can see the adults in June, resting on the foliage or flying erratically close to the strawberry plants. They are predominantly black, with distinct yellow stripes on their bodies and legs. These moths, which are about  $\frac{1}{2}$  inch long, are occasionally confused with yellow jackets because of their clear wings and general body shape. The larvae, about 1 inch long when mature, have brown heads and whitish or pinkish bodies which are slender and distinctly segmented. They can be distinguished from the weevils by their elongate bodies and small but distinct legs.

### How they develop

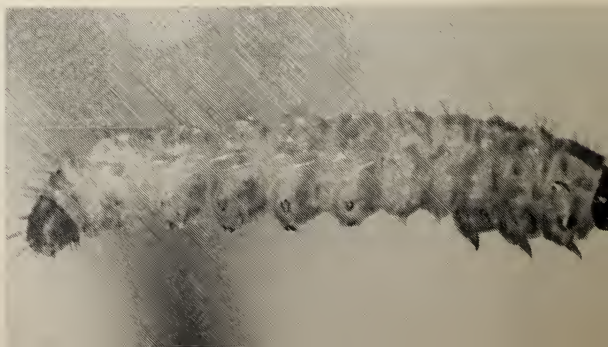
Moths emerge from strawberry crowns in June or July. Soon after, and for several weeks, they lay brown, flat eggs, singly, on the undersides of leaves and

on other objects near plant crowns. The eggs hatch in about 10 days and the larvae immediately crawl to the crown of the plant and bore into the wood. After rather extensive tunneling the larvae form thin silken cocoons in which they spend the winter. They resume their feeding in the spring and continue until pupation in May and June. The larvae pupate within the crowns of the plants after spinning a second cocoon. There is a single generation per year.

### Damage

Crown-moth larvae do all of their feeding within the crown of the plant. They tunnel through the wood depositing large quantities of excrement, and finally completely hollow out the crown, killing the upper portion of the plant. You may notice the damage in the fall or spring depending on how long it takes to completely destroy the crown. Since the larvae may restrict their feeding to one of several crowns on a plant, only a portion of the plant may be killed. Because the eggs are laid singly by a flying moth, individual plants are attacked sporadically over a field. Although the larvae may feed on several crowns of a single plant, they do not move from one plant to another. Thus, unlike the soil inhabiting pests, crown-moth damaged plants are found scattered among healthy plants.

Strawberry crown moth. Left, an adult moth. Right, underside of larva showing small but distinct legs.





The pest usually becomes more serious as the acreage of strawberries in an area increases. Likewise, older areas of strawberry production are more likely to have crown-moth infestations. Generally, however, the pest builds up seriously only when fields are poorly kept, and crown-moth infested plants are allowed to remain in the fields. Unfortunately, well-kept fields can be infested with many moths if there are other poorly kept fields in the area.

The crown moth sometimes prefers to lay its eggs on certain areas or types of growth. Also, healthy, vigorous plants can tolerate crown-moth attack better than plants in dry areas. Yet, when populations become high all plants are subject to attack.

### Control

In most cases the crown moth can be kept under control by pulling and destroying plants that show damage. Since the larvae remain within the same plant for most of the year it is easy to destroy them before they emerge in June or July. After removing infested plants, you can immediately replace them with new plants without danger of further injury.

Chemical control of the crown moth is difficult. The moths fly in June and July when it is impractical to use most insecticides because of the residue that will remain on the fruit. Once the larvae enter the crown they remain there for about eleven months, where it is almost impossible to contact them with an insecticide. Even highly toxic systemic insecticides have given little or no control when applied as high-gallonge drenches over the crowns of the plants.

Methyl bromide fumigation as carried out for cyclamen-mite control will give good control of crown-moth larvae. It is hardly ever practical to fumigate for crown-moth control alone. However, at times it might be desirable to modify the time of cyclamen-mite fumigation to include crown-moth control. This would



Crown of strawberry plant partially hollowed out by larva of strawberry crown moth.

mean delaying mid-season fumigation until after the flight in June and July.

### STRAWBERRY ROOTWORM

The strawberry rootworm, *Paria cancella* (Say), previously a serious pest of strawberries, has become much less prevalent since the new insecticides have come into common use. Nevertheless, at times this pest becomes established in a field and, if left uncontrolled, may cause serious damage.

#### What the rootworms look like

You may find adult rootworms—nearly always females—around the base of the plant during the day. They are round beetles, about  $\frac{1}{8}$  inch long, dark brown with four more or less distinct black spots on their backs. The larvae—also about  $\frac{1}{8}$  inch long—feed on the roots. They have slightly curved white bodies and distinct brown heads. Although somewhat similar to the weevils, they can be readily distinguished by their small, but evident, three pairs of legs.





Strawberry rootworm. Left, adult. Right, larva.

### How they develop

Strawberry rootworms overwinter as adults under trash or in cracks in the ground in a strawberry field. They become active early in the spring and after feeding for about a month begin to lay their eggs around the crowns of the plants. Immature stages are present from April till October with larvae being most abundant in June and July. There is one and perhaps a partial second generation. The adults emerge through the late summer and fall, feed on the leaves, and go into hibernation with the advent of cold weather.

### Damage

The pest damages both the leaves and roots of strawberries. The adults feed on the foliage and cause many very small round holes which give the leaves a characteristic shot-hole appearance. Such feeding is not serious, but indicates that the roots are infested with larvae which, if sufficiently abundant, may kill the plants. The plants usually decline in June, July and August, with damage appearing in scattered areas over a field.

### Control

This pest can be rather easily controlled because of its habit of feeding on the foliage during the fall and spring of the year before egg laying commences. Certain residual insecticides will give good control. Apply when all the individuals are in the adult stage—preferably in March or late October, when the beetles are actively feeding, and thus have more opportunity of contacting an insecticide. During the winter, control is less satisfactory since the beetles remain inactive and hidden around the crowns of the plants.

You can also effectively control the rootworm by treating the soil before planting with residual-type insecticides as used for other soil-inhabiting pests.

### HOPLIA BEETLES

White grubs belonging to the genus *Hoplia* cause severe damage to strawberries in certain areas. The larvae feed on the roots and often injure extensive areas in strawberry fields. Plants usually are not killed outright, but are left in a con-

dition so seriously weakened that they never recover.

*Hoplia* beetles are a potential pest in most of the strawberry growing areas but are most commonly found in the Central Valley. The beetle is a native insect which feeds on perennial grasses but may attack strawberries and blackberries. Serious infestations frequently result when strawberries are planted on ground that has been in or near permanent pastures. Infestations occur usually in light sandy soils, but heavy soils do not preclude attack.

### What the beetles look like

*Hoplia* adults are rather robust beetles about  $\frac{1}{4}$  to  $\frac{3}{8}$  of an inch long which you may see crawling and flying about strawberry fields on warm sunny days in May. Unlike a closely related species which feeds on grapes, this species is a poor flyer which remains inconspicuous even when present in large numbers. The beetles, which are covered with scales, vary in color from light to dark brown with the back part of the abdomen almost silver.

The larvae are typically C-shaped white grubs, slightly more than  $\frac{1}{2}$  inch long, found on the roots of strawberries.

They are white with brown heads and large, plainly evident legs. The back part of the body is somewhat enlarged and bulbous and has numerous hooked spines on its underside.

### How they develop

*Hoplia* beetles emerge in May and are active for about two weeks. They mate immediately and lay eggs in the soil about a week after emerging. The eggs hatch in about two weeks and the larvae begin to feed on the roots. They continue to feed until winter and then remain inactive in an earthen cell. They feed all of the succeeding year and overwinter a second time as large larvae. After feeding in the spring they pupate in April and emerge as adults in May. Two years are required for each generation, and damage usually is not evident until the beginning of the second year.

### Damage

*Hoplia* damage is limited to the larvae feeding on the roots. They devour the root hairs and scrape the bark and cortex from the larger roots. Unlike the weevils they cannot penetrate into the crown, and they cause slower, more gradual injury of the entire root system. Dur-

*Hoplia* beetle. Left, adult. Right, larva or white grub.





ing the first year when the larvae are small there is little noticeable effect from their feeding. It is in the second year, often in the spring just before pupation, that the plants begin to decline. Instead of wilting down completely, they generally remain alive in a very weakened condition. After the adults emerge you may not be able to find any larvae, but the plants do not recover because of extensive injury to the larger roots. Damaged plants often occur in limited circular areas, because the females are very poor fliers.

Although the *Hoplia* beetle looks very similar to the species that is commonly found feeding on flowers and tender foliage, it does little or no feeding as an adult.

### Control

*Hoplia* grubs can be controlled by mixing an insecticide into the soil before planting. You may get effective control from most of the persistent insecticides commonly used to treat the soil, except for DDT. Control of the adults is not feasible because they do not feed, and because they are active above the ground for a short time only. Although *Hoplia* grubs are more susceptible to insecticides than most of the other root-feeding pests, they are very hard to control in planted beds because it is difficult to get insecticides into the beds.

### OTHER WHITE GRUBS

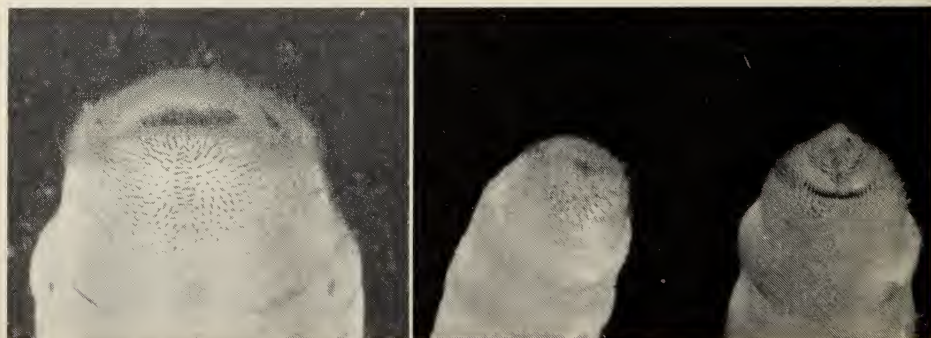
Besides *Hoplia*, there are several other white grubs which may damage strawberries in California, usually only in small areas.

Larvae of the ten-lined June beetle, *Polyphylla decimlineata* (Say), are the most striking because of their size. These grubs, which reach more than two inches in length and  $\frac{1}{2}$  inch in diameter, sometimes move down the beds and completely devour the roots on each plant they encounter, much like a gopher. Since they occur in low numbers, they can usually be dug out and destroyed. You can recognize their immature larvae by the two longitudinal rows of spines on the underside of the last abdominal segment. They require three years to complete their development.

White grubs belonging to the genus *Serica* likewise may damage strawberry fields. They are similar to *Hoplia* in their life histories and habits but are generally restricted to small areas in a field. You can identify them by a transverse row of comb-like spines on the underside of the last abdominal segment, and by their tendency to uncurl and crawl when dug out of the ground.

### BRACHYRHINUS WEEVILS

Several species of *Brachyrhinus* attack strawberries in California [*B. sul-*



Three similar species of white grubs can be distinguished by close-up observation of their posterior segment. Left: The ten-lined June beetle shows the longitudinal row of spines. Center: *Hoplia*. Right: *Serica* grub showing the transverse row of comb-like spines.



*catus* (Fabricius), *B. cribricollis* (Gyllenhal), *B. meridionalis* (Gyll.) and *B. rugosostriatus* (Goeze) ]. Since they have similar life histories and cause the same type of damage, they are discussed here as *Brachyrhinus* weevils. They are mainly pests of ornamental plants in California, but now and then they attack agricultural crops such as strawberries and blackberries. They are not particularly serious in any one area, but attack fields here and there throughout the state. Often infestations can be traced to infested ornamental plants near strawberry fields, or to strawberries planted on ground previously used for nursery plants.

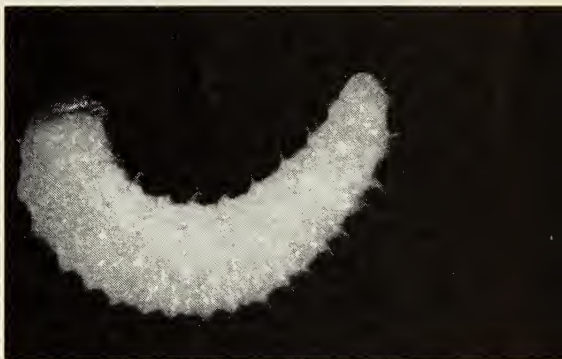
The true strawberry root weevil, *B. ovatus* (Linn.), a serious pest in Oregon and Washington, has been found in California on repeated occasions but has never developed into a serious pest.

### What these weevils look like

The adult beetles feed at night; during the day you can find them hidden around the crowns of the plants. They vary in length from  $\frac{1}{4}$  to  $\frac{3}{8}$  of an inch. Their color ranges from light or dark brown to almost black. They are relatively shiny and have no scales except for the black vine weevil *B. sulcatus* which is covered with patches of yellow scales. All of the species have distinct lines of punctures on their wing covers. The larvae have curved, white or pinkish bodies that are almost  $\frac{3}{8}$  of an inch long when fully grown. They have distinct brown heads but no legs.

### How they develop

*Brachyrhinus* adults generally emerge in May, although occasionally adults



Top: Adult of the black vine weevil showing patches of yellowish scales on its back. Center: Larva of the black vine weevil, *Brachyrhinus sulcatus*. Right: Adult of *Brachyrhinus cribricollis* showing the eyes on the front of the head.

may be found in the latter part of April, and *B. cribricollis*, a late emerger, is usually not evident until June. The adults, nearly all females, emerge over a relatively short time, feed on the foliage for about a month, then lay their eggs in the soil around the crowns of the plants. The adults remain active for several months, and occasionally a few may survive through the winter. The larvae hatch from the eggs in about 10 days, move down to the roots, and continue to feed until the weather becomes cool. Most individuals spend the winter as partially grown larvae within earthen cells. In the spring they start feeding again and do extensive damage before they pupate in April. There is a single generation per year.

### Damage

*Brachyrhinus* larvae feed by chewing on the roots of strawberries. They completely destroy the smaller rootlets and scrape the bark and cortex from the large main roots. Occasionally, you may find larvae feeding within the woody crowns of the plants. Usually the first symptom of their attack is a rapid decline of the plants in March or April just before the larvae pupate. Since the adults cannot fly, areas of damage are localized and expand each year. The adults chew the edges of the leaves so the foliage has a

Typical feeding injury caused by the adult *Brachyrhinus* weevils.



scalloped appearance, but they seldom destroy sufficient leaf surface to seriously affect the plants.

### Control

*Brachyrhinus* weevils can be controlled by mixing a persistent insecticide into the soil before planting. After the plants have been established, control measures must be directed against the adults. Since the adults all emerge about the same time and do not lay eggs for a month or more, it is practical to attempt control of this stage. Make one or two applications of a dust or spray after all the adults have emerged but before they start laying eggs. The proper time to apply the insecticide can be determined by observing adult feeding injury and digging plants to determine what stages the weevils are in. Some insecticides are highly effective, but since emergence takes place during the picking season, it is often desirable to use a less effective material which will not leave a toxic residue on the fruit for such an extended period of time. Because the weevils occur in localized areas, it is sometimes possible to spot-treat infested areas and thus restrict residues on the fruit to the infested areas. Poisoned baits which are highly effective against the strawberry weevil in the Northwest, are not usually satisfactory against *Brachyrhinus* weevils in California.

### FULLER ROSE BEETLE

Fuller rose beetle, *Pantomorus godmani* (Crotch), another common pest of ornamental plants, can cause serious damage to strawberries. The larvae, through their feeding on the roots, may at times kill strawberry plants in large, more or less circular, areas of a field.

### What the beetles look like

The adults feed at night; during the day you can find them around the base of the plants. They are about  $\frac{3}{8}$  inch long with short, broad snouts, and el-





Left: Adult of Fuller rose beetle. Right: Two weevil larvae showing the white head of the Fuller rose beetle and the brown head of *Brachyrhinus* sp.

bowed antennae. Their color varies from light brown to almost gray, and they have an oblique whitish band on the side of each wing cover.

The larvae are legless with curved white bodies, about  $\frac{3}{8}$  inch long. Their heads, unlike the other weevils, are pale, almost white, with only the mandibles dark brown.

### How they develop

This weevil overwinters mainly in the larval stage, but some adults persist through the winter. The larvae develop in the spring and early summer and cause the greatest damage in early summer. Pupation takes place in the ground; the adults emerge from July through November, most of them in late summer. They lay their eggs around the crowns of the plants; after hatching, the larvae work their way down into cracks in the soil to feed on the roots of the plants.

### Damage

The legless larvae of Fuller rose beetle feed on the roots of strawberries. They completely devour the smaller rootlets and destroy the bark and cortex on the

larger roots. Symptoms of their attack are a rapid wilting of the plants when roots no longer can provide moisture for the leaves. Such damage becomes particularly evident on warm days in April and May. It is not uncommon to find weevil larvae which have penetrated into the lower portion of the crown of the plant.

The adults feed on the foliage and remove large scallops from the leaves in a manner characteristic of the broad-nosed weevils. Such leaf damage indicates the presence of the pest but is usually of negligible importance.

### Control

Larvae of the Fuller rose beetle can be controlled by mixing one of the persistent insecticides into the soil before planting. On established plantings adult control is most practical, but it is difficult because most of the effective insecticides leave a residue on the berries for some time, and numerous applications must be made to control the adults which emerge from July till November. Poisoned baits are not satisfactory for control of Fuller rose beetle.



## NEMOCESTES WEEVILS

The *Nemocestes* are another group of root-feeding weevils that have become important on strawberries in recent years, particularly in the coastal areas around Santa Cruz and Watsonville. The weevils live naturally on blackberries and other shrubs which grow in the gullies of this area. When strawberries are planted nearby, the weevils crawl into the fields and establish themselves. You can often first spot signs of damage near fence rows and uncleared areas.

The most important species in California are *Nemocestes incomptus* (Horn), *N. fragariae* Van Dyke, *N. sordidus* Van Dyke, *N. longulus* Van Dyke and *Peritelopsis globiventris* (Lec.). Since they are closely related, all species are treated as a group.

### What the weevils look like

The adults feed on the foliage at night. During the day they are crowded around the crowns of the plants, but because of their colors are not easy to see. They are

rather robust beetles. The species differ in size: *N. fragariae* is the smallest (about  $\frac{1}{8}$  of an inch), *N. incomptus* the largest (slightly more than  $\frac{1}{4}$  inch). Their bodies are covered with variably colored scales which give them a dull, predominantly light or dark brown appearance. Some are almost uniformly brown, others have a more or less checkered pattern of light and dark scales. They are extremely difficult to see against the ground, and when they become coated with dried mud, they appear to be just another small clod of soil.

The larvae, like the other weevils, are legless, white or pinkish, and somewhat crescent-shaped. They vary from  $\frac{1}{8}$  to slightly more than  $\frac{1}{4}$  inch in length when mature. Their brown heads resemble the *Brachyrhinus* weevils, but you can usually distinguish them by the somewhat brownish lobes on the back part of the body. With the aid of a microscope they can be identified by the straight row of very short, stout spines on the underside of the last abdominal segment.

### How they develop

The different species of *Nemocestes* emerge at different times of the year, and each species emerges over a rather extended period of time. Most of the species tend to emerge in July and August, but populations of *N. incomptus* may emerge in the fall, and *Peritelopsis globiventris* adults usually appear in May. After emergence the adults feed on the foliage for two or three weeks before they lay eggs around the crowns of the plants. They remain active for several months, and a few may survive through the winter. As soon as the eggs hatch the larvae move down and feed on the roots. The larvae are less active during cool weather, but some feeding takes place through the winter; feeding activity increases in the spring, and continues until the larvae pupate about a month before the adults emerge. There is a single generation per year.



Adult of *Nemocestes incomptus*.



Left: Adult of *Peritelopsis globiventris*. Center and right contrasts the posterior segments of *Brachyrhinus* weevil larva with that of the *Nemocestes*, showing the brownish lobes and straight row of spines.

## Damage

*Nemocestes* cause injury similar to the other root-feeding weevils. They feed on the root hairs, remove the bark and cortex from the main roots, and penetrate the crown to a certain extent. Since large larvae do most of the damage, the plants decline most rapidly in the spring and early summer. Larvae of the *Nemocestes* differ from the other root-feeding pests by their tendency to leave the dying plants and move to the next healthy plant. That is why damaged areas have a center of old dead plants, a ring of recently killed plants, and a perimeter of slightly damaged plants. The adults crawl but do not fly and, as a result, damaged areas continue to expand from year to year.

Even in fields where the weevils are abundant and damage is evident, you may not be able to find them. Because they tend to leave dying plants, they can often be found only under plants which are just beginning to show damage. Also, moles frequently move into infested areas and destroy the larvae.

## Control

The *Nemocestes*, unlike the other weevils, cannot be controlled by mixing persistent insecticide into the soil before planting. Most of the commonly used soil insecticides have little or no effect on

them. Lindane will give control for one year but cannot be used on strawberries because it tends to impart a flavor to the berries.

Control of the adults is likewise difficult. Many of the insecticides which are effective against other weevils are ineffective against *Nemocestes* adults. Even with effective insecticides it is difficult to devise a practical control, for the adults emerge over an extended period



Injury caused by *Nemocestes* weevils feeding on the roots of strawberries.



during the picking season and sufficient applications raise a serious residue problem. Poisoned baits, although not a good control for these weevils, may reduce populations appreciably if properly timed. Apply them when the adults start to emerge, and repeat every two or three weeks until all the adults have emerged.

### GROUND MEALYBUG

The ground mealybug, *Rhizoecus kon-  
donis* Kuwana, is another soil-inhabiting pest which weakens and kills plants in more or less circular areas. It attacks ornamental plants, weeds, deciduous fruits, and berries. We do not know for certain whether mealybugs damage fruit trees, but strawberries planted in fields from which infested trees were removed may be severely damaged. The pest has been particularly serious in the Santa Clara Valley when strawberries have been planted soon after removal of apricots, prunes, and cherries.

Roots of infested plants, instead of having the bark removed, are covered

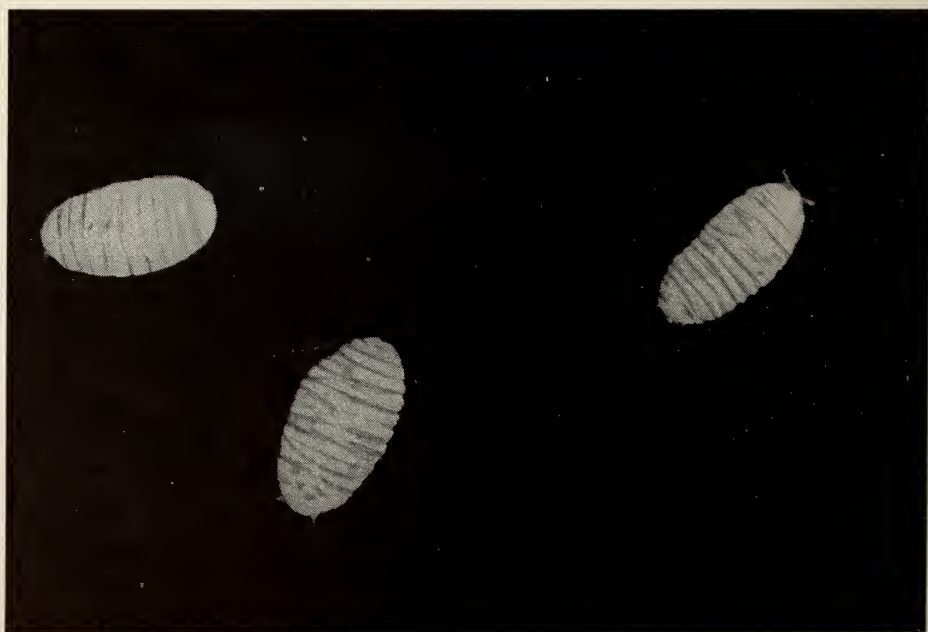
with a white waxy deposit which the mealybugs secrete. Since certain fungi may also cause white areas on the roots, it is necessary to observe the mealybugs to ascertain that they are actually the cause of the damage.

### What mealybugs look like

Presence of the ground mealybug is suggested by a cottony deposit on the roots of strawberries. You may find the adults (about  $\frac{1}{16}$  of an inch long) hidden beneath this white wax that they secrete. Their segmented, egg-shaped bodies are snowy white from the powdery wax that covers them. They have three pairs of small legs and short thick antennae.

### How they develop

Ground mealybugs overwinter as adults and immatures; are not very active during the winter, but continue to feed to a limited extent. They feed more in the spring but usually do not start to lay eggs until summer; then all stages



Ground mealybug.



can be found until fall. This pest remains beneath the surface of the soil throughout the year.

### Damage

Ground mealybugs cause injury by sucking plant juices from the roots of strawberries. Unlike the other root-feeding pests, they do not scrape the bark from the roots, but instead merely cause a general decline which finally weakens and kills the plants. Since the injury is gradual, plants are most apt to wilt when warm weather taxes the water-carrying capacity of the roots.

### Control

There is no satisfactory control for this pest on ornamental plants or strawberries. Continued working of the land after removal of fruit trees will give control, but it is often impractical to delay planting long enough. To kill most of the mealybugs it would probably be necessary to have a field free of trees and weed hosts for about six to nine months during the warmest part of the year.

Soil fumigation with EDB or DD, as used for nematode control, will reduce mealybug populations, but not kill all individuals deep in the soil. EDB emulsified in the irrigation water, as sometimes used against *Hoplia*, gives some control, but populations usually attain previous levels in a relatively short period of time.

### GARDEN SYMPHYLID

The garden symphylid, *Scutigerella immaculata* (Newport), is an occasional pest of many truck and field crops, and is particularly serious on asparagus. Strawberries, although not commonly attacked, may at times be killed by this root-feeding pest.

The garden symphylid will probably be a pest of strawberries only in fields which have built up high populations on other crops. They are most destructive

in the heavier-textured soils, and adequate soil moisture is seldom a limiting factor as they can move up and down in the soil for several feet.

They are small ( $\frac{3}{16}$  inch long), white fragile animals that move rapidly through cracks and crevices in the soil when it is broken apart from beneath infested plants. Their twelve pairs of legs and bead-like antennae can hardly be seen without a magnifying glass.

### Control

Control of this pest in established strawberries is very difficult. Even on well-worked soil only moderate control has been obtained because part of the pest population lives very deep down. Soil fumigation and certain insecticides mixed into the soil are two methods which have brought moderately good results.

### WIREWORMS

Wireworms are immature stages of "click beetles." They are widespread pests on many crops, but damage strawberries only occasionally. The larvae take one or more years to mature, feed on the roots, and thus reduce the general vigor of the plants.

The yellow or brownish larvae are smooth and shiny. Their narrow, cylindrical bodies (usually less than 1 inch long) are covered with a remarkably tough skin. The back part of the abdomen is flattened, and often split in back so that it has a characteristic keyhole appearance.

### Control

Wireworms can be controlled by mixing one of the persistent insecticides into the soil before planting. Soil fumigation with EDB or DD when used for nematode control will also give control. After strawberries have been planted, there is little that can be done for control.

## Careers Available

DAVIS.—"Jobs we can't fill; that's our graduation story every year," says Warren P. Tufts, chairman of the Department of Pomology on the Davis campus of the University of California.

"The demand for good personnel is not surprising when you consider that California produces about one-half of all the fruits in the United States. The fruit industry will always be important in this state, because of its favorable climate and soils and the great variety of crops. Trained people are always wanted in the fruit and allied industries—in growing, fertilizer and spray chemicals, inspection service, canning, quick freezing, and shipping.

"At all times, the Department of Pomology has standing requests for promising personnel, with the promise of several firms to make openings for recommended students if no openings already exist. Some year we hope we'll be able to supply the demand."

## Pomology today

A knowledge of fruits and fruit-growing offers many fine careers. And the best positions go to those who have mastered the subject through a balanced program of training.

At Davis the course in pomology is balanced between practice and theory—the "how" and the "why"—using the finest facilities . . . taught by one of the largest and best-trained horticultural staffs in the world.

The Department of Pomology maintains about 300 acres of orchards, containing nearly all the important varieties of deciduous tree fruits, nuts, olives, and berries (strawberries, boysenberries, etc.). The student has an opportunity to become acquainted with most of the fruit-grower's techniques of production and marketing. He becomes familiar with the best and most modern orchard equipment.

For study and research, facilities also include a packing house, complete sun-drying and dehydration equipment, a cold-storage plant, lath-houses and green-houses, and laboratories equipped with apparatus for fundamental studies.

The staff of the department includes specialists in fruit breeding, pruning, pollination, spraying, irrigation, fertilization and plant nutrition, soil management, physiological plant diseases, propagation, varieties, harvesting, handling, and storage of fruits and nuts.

### Trained people are in demand for . . .

#### PRODUCTION

- Orchard management
- Orchard operation

#### PROCESSING

- Packaging • Canning
- Freezing • Drying

#### DISTRIBUTION

- Purchasing • Selling
- Marketing • Shipping

#### SERVICE

- Fertilizers • Sprays
- Equipment • Nursery

#### OTHER

- Agricultural Extension
- U. S. Dept. of Agriculture
- State Dept. of Agriculture
- Teaching—School and College
- Research—Industry, University